

Hard Chrome Alternatives for Hydraulic Components

- Program established to assist Oklahoma City Air Logistics Center Airborne Accessories Directorate Avionics and Accessories Division (OC-ALC/LGERC) in development and implementation of replacement repair and overhaul procedures for hydraulic actuators across multiple weapon systems.



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Hard Chrome Alternatives for Hydraulic Components

- Phase 1 - TO and Drawing Review, Database Development, Test Requirement Development.
 - 124 Air Force Technical Orders Reviewed.
 - 100% complete.
 - 729 Engineering Drawings Reviewed.
 - 60.4% reviewed. Remaining drawings are not available
 - 276 Chrome plated parts and 195 potentially chrome plated parts have been identified.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Flight Control Actuators.
 - 87 distinct part numbers.
 - Revised estimate: 10 will require delta-qualification.
 - Candidate items selected.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Utility Actuators.
 - 73 distinct part numbers.
 - Revised estimate: approximately 10 will require delta-qualification.
 - 5 candidate items selected to date.
 - Snubbers.
 - 12 distinct part numbers.
 - Estimate: approximately 3 will require delta-qualification.
 - 1 candidate item selected.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Units undergoing delta-qualification
 - Flight Control: B-1 Horizontal Stabilizer
 - Flight Control: B-1 Pitch/Roll SCAS
 - Flight Control: C-130 Rudder Booster Actuator
 - Flight Control: A-10 Aileron
 - Flight Control: F-15 Pitch/Roll Channel Assembly (PRCA)
 - Utility: C-130 Ramp Actuator
 - Utility: C-135 Aileron Control Surface Snubber
 - Utility: C/KC-135 Main Landing Gear Actuator
 - Utility: C/KC-135 Main Landing Gear Door Actuator



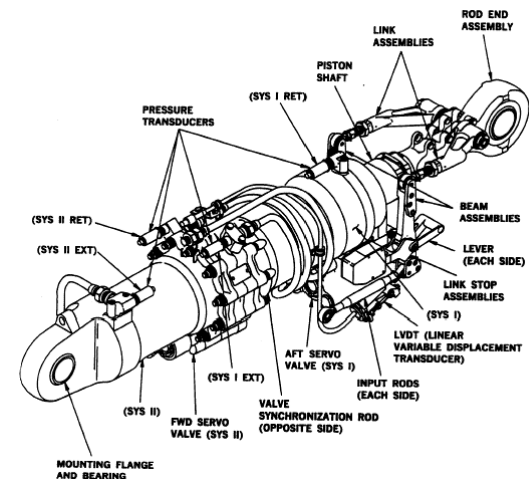
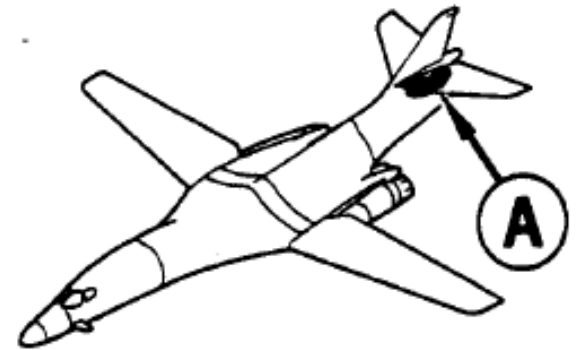
Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Planned
 - Special: KC-135 Ruddevator
 - T-38 Aileron Actuator



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Forward piston required redesign to eliminate fatigue failures (not related to chrome)
 - Design qualification required fatigue and endurance tests
 - Opportunity to include chrome alternatives in test
 - HVOF coatings replace chrome on forward and aft pistons
 - Endurance test included - approximately 750,000 cycles
 - Results will form basis for similarity arguments for other B-1 flight control actuators



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Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
- Piston redesign completed
- Fatigue testing completed
- Endurance testing completed
- Actuator awaiting disassembly and documentation



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
- Numerous product improvements to be investigated
- Will include incorporation of HVOF applied coating on primary piston and new seals
- Implementation to include design layout, coating prototype, fit check, simplified endurance schedule, and similarity argument



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - C-130 Rudder Booster Assembly.
 - Rudder booster actuator delta-qualification was contracted to Kaiser Fluid Technologies (OEM).
 - In ~March 2002, Kaiser Fluid Technologies was acquired by Tactair Fluid Control.
 - Qualified by Lockheed Martin.
 - Delta-Qualification being performed by Tactair Fluid Control.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - C-130 Rudder Booster Assembly.
 - 4 chrome plated surfaces.
 - Piston rod.
 - » 3 sections, with piston heads separating them.
 - » Significant straightness issues.
 - Piston head (2 piston heads on the unit).
 - » Not part of the piston rod.
 - Trunnion OD.
 - » Mates with an aluminum-bronze bushing.
 - Trunnion ID.
 - » Not wearing part.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Rod coating surface finish and seal selection.
 - 4 Configurations being tested:
 - Electroplated Chrome with AGT seals (baseline).
 - HVOF WC-CoCr with AGT seals (new coating, baseline seals).
 - HVOF WC-CoCr with new Greene Tweed seals (new coating, cap seals).
 - HVOF WC-CoCr with new Shamban seals (new coating, cap seals).



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - A-10 Aileron Actuator (Parker)
 - Seals being selected.
 - Vibration testing cancelled.
 - Test fixture under design.
 - Redesign of piston may be required.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - F-15 Pitch/Roll Channel Assembly (PRCA)
 - ARINC is working to award work to Moog as a Government directed source.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Utility actuators.
 - C-130 ramp actuator.
 - Part number 370750-1.
 - Stroke: 64.998” (maximum).
 - Extended/Retracted Length: 139.6” /74.6”.
 - Piston rod OD: 1.8”.
 - Piston rod Material: 4340.
 - Other coatings: None.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Utility actuators.
 - C-130 ramp actuator.
 - Two actuators planned for delta-qualification
 - Both actuators passed ATP and are ready for testing. First actuator should be completed by end of year.
 - Replacement scraper are being tested, but with limited success. Works fine with scraper oriented up. But when oriented horizontally, scrapers are not functioning as desired.







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Hard Chrome Alternatives for Hydraulic Components

Phase 2 - Material, Rig, Service Testing.

- C/KC-135 main landing gear door actuator.
 - P/N: 5-84045-9.
 - Stroke: 20.66” (nominal).
 - Extended/Retracted Length: 51.66”/31.00”.
 - Piston rod OD: 1.3”.
 - Piston rod Material: 4340 or 4140.
 - Other coatings: Cadmium.
 - Identical to E-3 main landing gear door actuator (P/N 50-6832-10).



Hard Chrome Alternatives for Hydraulic Components

Phase 2 - Material, Rig, Service Testing.

- C/KC-135 main landing gear door actuator.
 - Planned for disassembly in January, 2004.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Utility actuators.
 - C/KC-135 main landing gear actuator.
 - P/N: 5-84046-6.
 - Stroke: 13.78” (nominal).
 - Extended/Retracted Length: 44.62”/30.84”.
 - Piston rod OD: 2.995”.
 - Piston rod Material: AMS 6371C.
 - Other coatings: None.
 - Identical to E-3 main landing gear actuator (P/N 50-6833-9).



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Utility actuators.
 - C/KC-135 main landing gear actuator.
 - Units have been disassembled.
 - One unit found to be in very bad shape.
 - » Required 1300 ft-lbs to open housing.
 - » TO stated 350 ft-lbs maximum.
 - » Local shop has capability to apply up to 5500 ft-lbs torque to open housings.
 - Cleaning and inspecting components.
 - Replacing “bad” unit.





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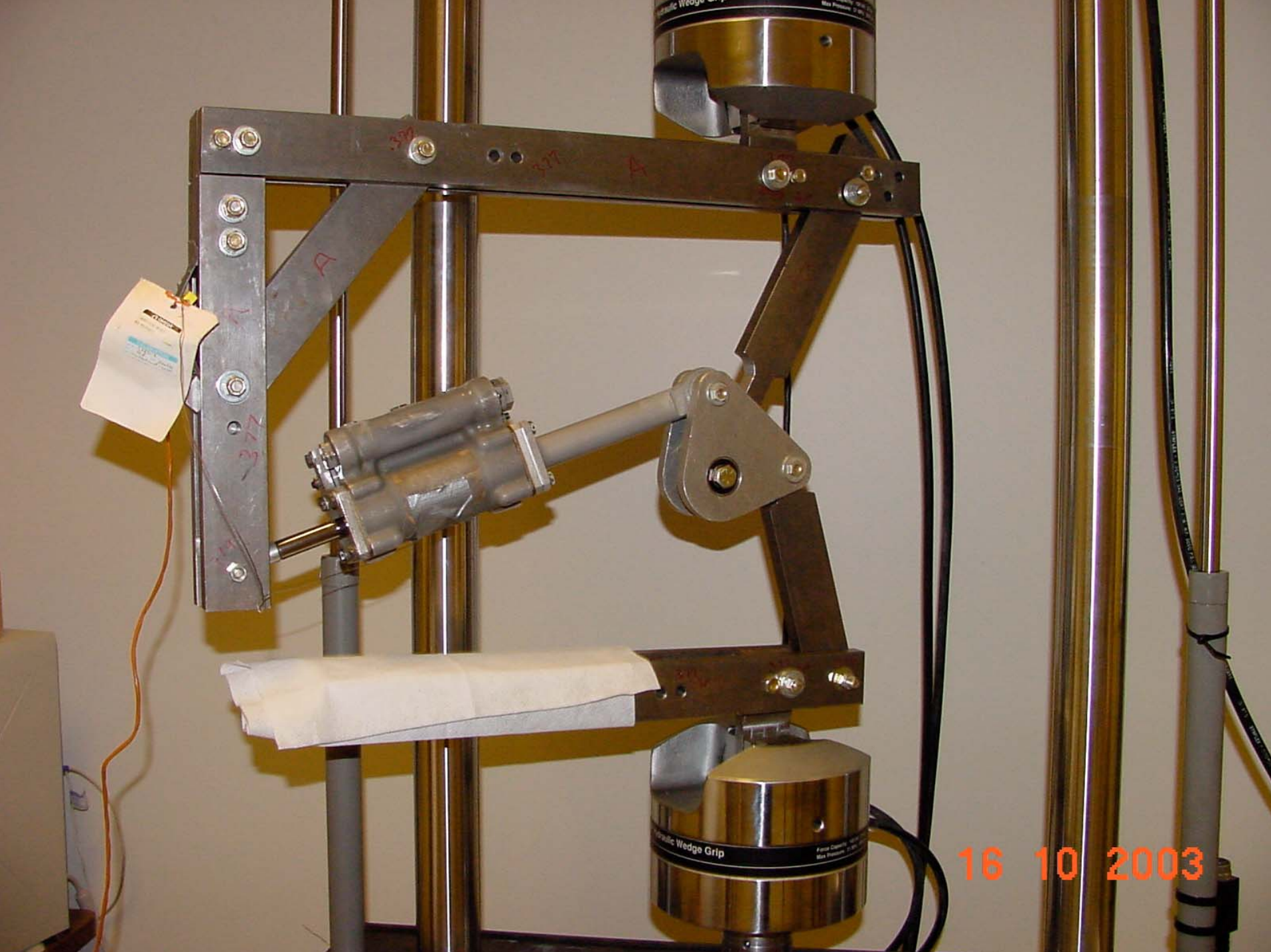
Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Utility actuators.
 - One C/KC-135 aileron snubber has been assembled and successfully passed delta-qualification testing.
 - Second C/KC-135 aileron snubber has passed cyclic testing.
 - Currently being leak tested.
 - Will be cold temperature tested after leak test.



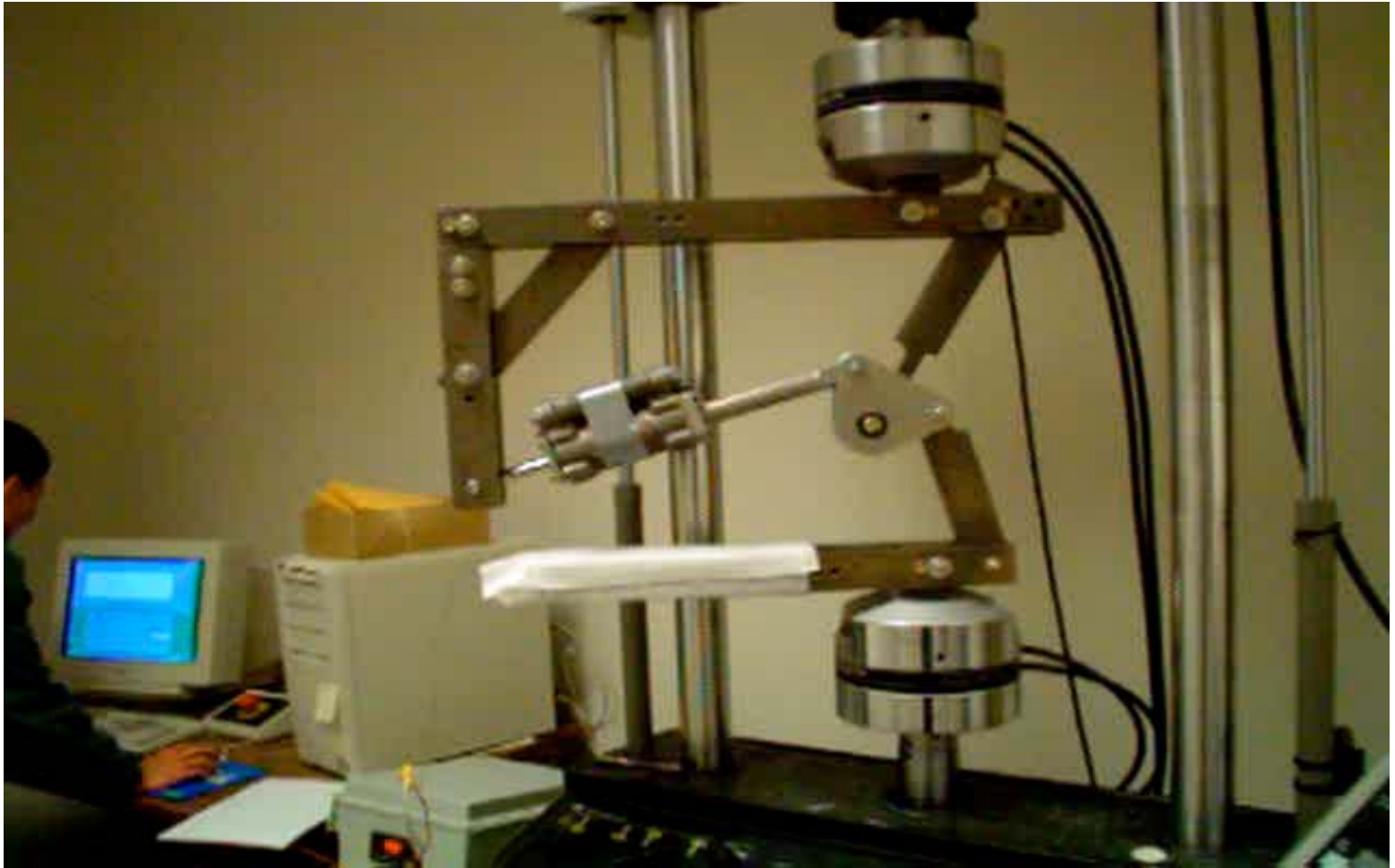


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Hard Chrome Alternatives for Hydraulic Components



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Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Special actuator.
 - KC-135 Ruddevator.
 - P/N: 65-6750-1.
 - Stroke: 5.875” (maximum).
 - Extended/Retracted Length: 25.580”/19.705”.
 - Piston rod OD: 0.746 to 0.748”.
 - Piston rod Material: 4140.
 - Other coatings: Cadmium.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Special actuator.
 - KC-135 Ruddevator.
 - Been placed on hold.
 - Cyclic testing will require 200,000 cycles. Most likely on hold until a facility capable of doing cyclic testing is located.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Service testing.
 - A 2 year service test is planned for all actuators and their similar components.
 - Example: C-130 rudder booster will be service tested concurrently with C-130 aileron and elevator actuators (based upon qualification by similarity arguments). Estimated to last two years.
 - Similar service testing planned for all other actuators.



Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
 - Service testing.
 - Drafts of C-130 and C/KC-135 Service Test Plans will be ready for Government on December 1.
 - Coordination of STPs to commence as soon as STPs are released.
 - Implementation of test plans to begin as actuators complete cyclic testing.



Hard Chrome Alternatives for Hydraulic Components

- Phase 3 - Data Evaluation
 - Results of Testing will be evaluated and a solution finalized.
 - This phase has not been reached yet.



Hard Chrome Alternatives for Hydraulic Components

- Phase 4 - Implementation
 - The solution developed during evaluation will be implemented.
 - This phase has not been reached yet.

